1. NAME OF INITIATIVE: CDMS III. The CDMS collaboration.

List of major collaborating institutions (including non-US partners).

The CDMS Collaboration consists of groups at Brown University. California Institute of Technology, Case Western Reserve University, Fermi National Accelerator Laboratory, National Institute of Standards and Technology, Boulder, Princeton University, Santa Clara University, Stanford University, University of California at Berkeley, University of California at Santa Barbara, University of Colorado at Denver, University of Florida, and University of Minnesota. There are approximately 45 physicists (including graduate students) in the collaboration.

2. SCIENTIFIC JUSTIFICATION:

Physics goals. How does it fit into the global physics goals for the entire field.

The scientific case for dark matter in the form of weakly interacting massive particles or WIMPs is more compelling than ever. A Standard Model of cosmology has emerged over the past decade from cosmic microwave background, supernova and weak lensing studies, where $\Omega = \Omega_{\lambda} + \Omega_{m} = 1$ with the dark energy $\Omega_{\lambda} = 0.73$, and the matter $\Omega_{m} = 0.27$. Further, $\Omega_{m} = \Omega_{b} + \Omega_{nb}$ where the baryonic matter $\Omega_{b} = 0.04$ and the nonbaryonic dark matter $\Omega_{nb} = 0.23$. An excellent candidate for WIMP nonbaryonic dark matter is the lightest supersymmetric particle - the neutralino. Supersymmetric models yield a wide range of neutralino mass and cross section predictions, much of which is accessible through direct detection experiments.

CDMS II is currently in the forefront of the search for WIMPs via direct detection of the nuclear recoils they would leave in matter. Our ZIP (Z-dependent Ionization and Phonon) detector technology uses simultaneous athermal phonons and ionization measurement to reject conventional backgrounds, and both Ge and Si targets to distinguish neutron backgrounds. Running deep underground in the Soudan mine, our recent limits on the spin-independent cross section for WIMP interactions are the best in the world by a factor of 4. Continued running with CDMS II through 2005 should improve these limits by another factor of 20, probing deep into the expected region for a SUSY neutralino. There is a good chance that a WIMP signal would begin to be seen during this period.

Until a limiting background is reached, the sensitivity of CDMS at Soudan improves linearly with exposure time. If a WIMP signal begins to emerge, it will be vital to continue running long enough to measure the WIMP cross section and mass. We expect that the neutron background due to cosmic ray interactions will begin to limit sensitivity improvements at Soudan by about the end of 2008. It is thus important to begin now the R&D on detectors and backgrounds that will be needed for a CDMS experiment with significantly larger target mass at a deeper site. We have expressed interest in being involved in the first phase of the expansion of SNOLAB, where space and facilities may become available as early as 2007. Starting in 2007, Soudan would also become a proving ground for new detectors that could be deployed at the deeper site like SNOLAB.

3. VALIDATIONS FOR SCIENTIFIC JUSTIFICATION:

Examples of recommendations and supporting statements from the committees, panels, and the community at large.

The CDMS III program was presented to the April 2004 meeting of the Fermilab Program Advisory Committee. Their report concluded that: "*The Committee was pleased by the CDMS-II collaboration's completion of two towers in Soudan and the successful start of data-taking. The Committee was also very impressed by the first science produced from the Soudan operation, which already excludes a very interesting region of the Dark Matter parameter space, and is the current world-best limit. The Committee fully supports the science of a seven-tower CDMS-III that will make the most out of the investment already made.*

We have also presented CDMS III to the April 2004 SAGENAP meeting. Verbal feedback was quite favorable and we await the written report from the committee.

Conference presentations of the new CDMS II results from Soudan have been very well received. It is clear that the scientific community is anxious for continuing improvements in direct detection sensitivity from CDMS.

4. DESIRED SCHEDULE:

List major milestones (month & year) such as design complete, construction start, construction complete, etc.

A CDMS proposal will be submitted to DOE (and NSF) this fall. It will outline several phases for the experiment, including:

Supplemental R&D funding for detector improvements and background screening: July 2004 – Dec. 2005

CDMS WIMP search:

Soudan phase (CDMS III): Jan 2006 – Dec. 2008

In addition, there will be a proposal for a Low Background Counting Facility at Soudan that CDMS will support as a major user.

If things continue to progress well with CDMS at Soudan, and the SNOLAB upgrades happen on schedule, we may submit a proposal as early as FY2006 for a SNOLAB phase of the experiment. The initial phase could be a continuation of the Soudan experiment at the deeper site with our best detectors (largest mass, lowest background) and could be assembled fairly quickly with existing equipment. The maximum target mass of this phase would likely be 20 kg. A later, larger phase of CDMS at SNOLAB or DUSEL would be aimed at target masses in the range 100-1000 kg.

5. ROUGH ESTIMATE OF COST RANGES:

Whatever the best information available (e.g. $M +/-30~50%, $150~250M, etc.). Total cost range including non-DOE funding (if any other funding sources are assumed and if known, state from where and how much. Also indicate remaining R&D cost to go.

Cost estimates are still being developed, but the scale is approximately:

Supplemental R&D funding for detector for detector improvements and background screening: $2M

CDMS WIMP search:

Soudan phase (CDMS III): ~$20M

Possible initial SNOLAB phase: ~$40M

6. DESIRED NEAR TERM R&D:

Major activities needed to be completed before start construction.

It is vital to conduct R&D in several areas of CDMS. We believe that the ability of our ZIP detectors to reject conventional backgrounds can be improved further beyond the already impressive results. This will require a combination of modest changes in fabrication, coupled with testing and detailed analysis of data taken at Soudan. There is also considerable room for improvement in the level of background contamination on, and around, the detectors, especially surface electron backgrounds. We need a combination of industrial surface screening techniques and a low background counting facility at Soudan in order to achieve this background reduction. Additional R&D on neutron vetoing may also be needed to take full advantage of the CDMS experiment at Soudan.

7. BRIEF DESCRIPTION OF LABORATORY'S ANTICIPATED ROLE:

Expected unique capabilities to be provided by lab. Rough estimate of human resources from lab (#FTE in what type labor).

Fermilab provides the project management for CDMS. It also supplies much of the engineering and technical expertise in support of cryogenics, electronics, computing, and operations at Soudan (currently about 4 FTE's). While we anticipate that this support will continue, the laboratory would like to broaden its share of the science of CDMS. This will require an increase in the Fermilab data analysis effort on the experiment. Another important contribution would be a better understanding of the backgrounds from radioactivity and from cosmic ray interactions. This is the key to further progress in direct detection experiments such as CDMS and it would allow us to play a leading role in the design of the next phase of CDMS at a deeper site such as SNOLAB. A key element of this work will be participation in the upcoming low background counting facility at Soudan.

To expand the Fermilab role in CDMS will require the addition of scientific personnel, at both the Research Associate (postdoc) and Associate Scientist levels. Currently we have 2 FTE's and would need to ramp up to a level of 4-5 FTE's to handle the increased participation. Additional engineering and technical resources (at least 2 additional FTE's) will likely be needed to design and construct the new CDMS infrastructure at a deep site.